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Multi-patched epidemic models with partial mobility, residency, and demography

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The emergence and re-emergence of infectious diseases has been a global cause of concern in the past few decades. Previous research in the field has revealed that human connectivity and mobility behaviour play a major role in the spreading of an infectious disease. In this work, we propose a new model that describes the effects of human mobility on the evolution of disease dynamics in a multi-population environment. We develop SIRS and SEIRS multi-patch and multi-group epidemic models and extend the notion of virtual dispersal that was assumed by (1) and (2) by introducing a mobility parameter. Furthermore, we capture the proportion of time that different groups with different epidemiological statuses spend in the other environments. Various numerical simulations are conducted to study the effects of the change in mobility and the residence time matrix on the evolution of the disease in individual patches and the overall environment. This is done on the basis of the basic reproduction number $\mathcal{R}_0$ which we compute for both models. We rigorously show that the disease free equilibria (DFE) for both models are stable when $\mathcal{R}_0 \leq 1$. We also show that the models have a unique endemic equilibrium when $\mathcal{R}_0 > 1$.

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